Structure, dynamics and stellar population characterization of massive virtual galaxies at z=0

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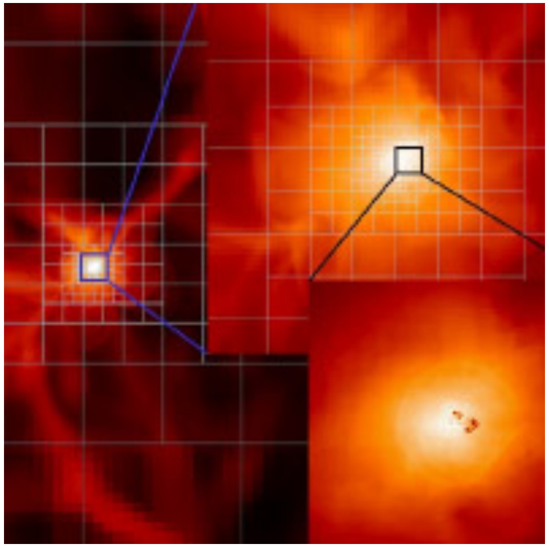
EWASS 2013, Turku

THE SIMULATION



Mesh Adaptive Scheme for Cosmological structurE evoluTion cosmological N-body and Eulerian hydrodynamical code (Quilis 2004)
Based on Adaptive mesh refinement (AMR)

- ✓ Gas cooling
- ✓ Star formation
- ✓ SNII feedback (Salpeter IMF)
- ✗ AGN feedback

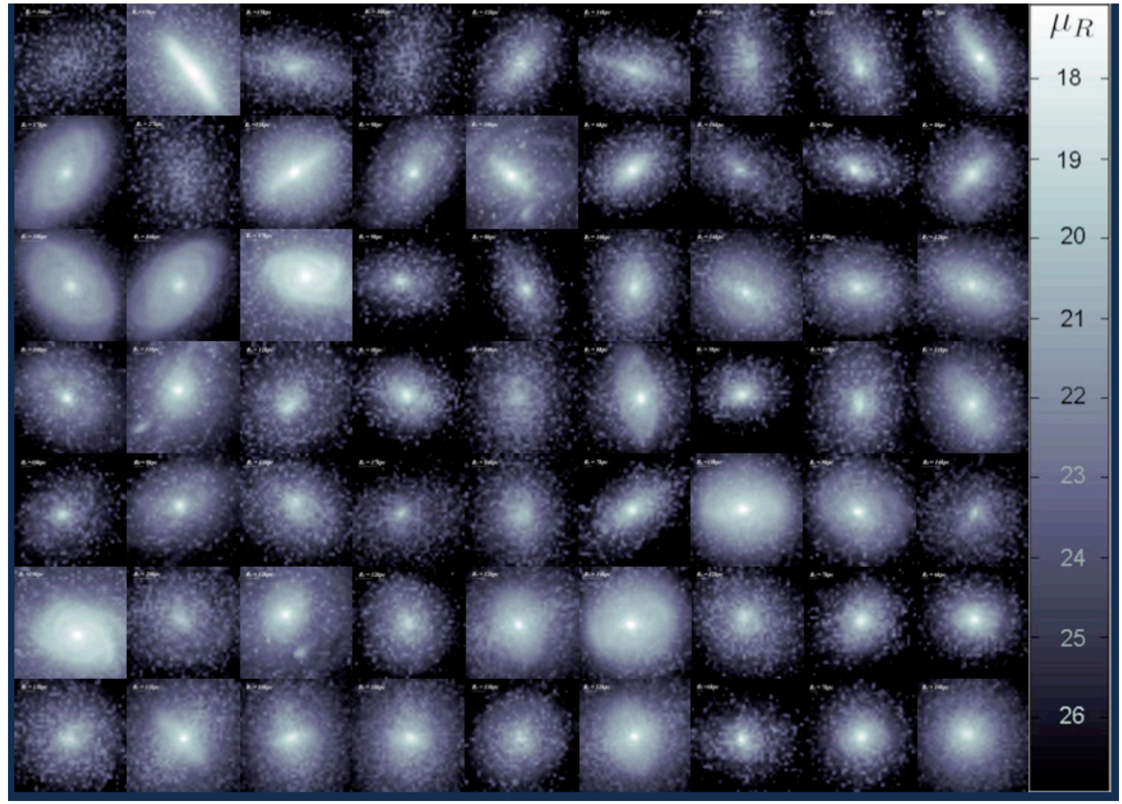
(we expect to find too massive/young galaxies)

Side length of the box: **44 Mpc**
Base level resolution (l=0): 128^3 (0.34 Mpc)
Levels of refinement: 7
Best spatial resolution (l=7): **2.7kpc**
Best DM particle mass: m=2E7 Msun
Cosmology: $\Omega m=0.25$; $\Omega_{\Lambda}=0.75$, h=0.73

MASSIVE GALAXIES

- ✓ Galaxies identified by means of an adaptive friend-of-friends algorithm applied to the star particles (HALMA): LL=3 kpc
- ✓ We select massive ($M>10^{11}M_\odot$) and well resolved galaxies (level=7; 2.7 kpc)

→ Sample of 21 galaxies @z=0



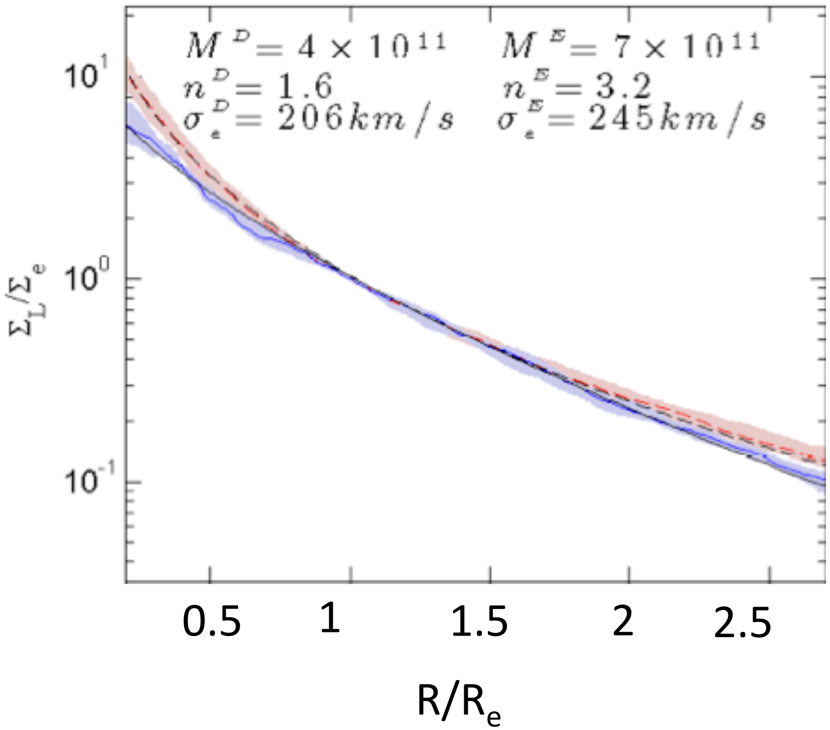
3D structure projected along the 3 coord axes to create 2D maps (pixel size=2.7 kpc)

MILES

→ 63 virtual galaxies

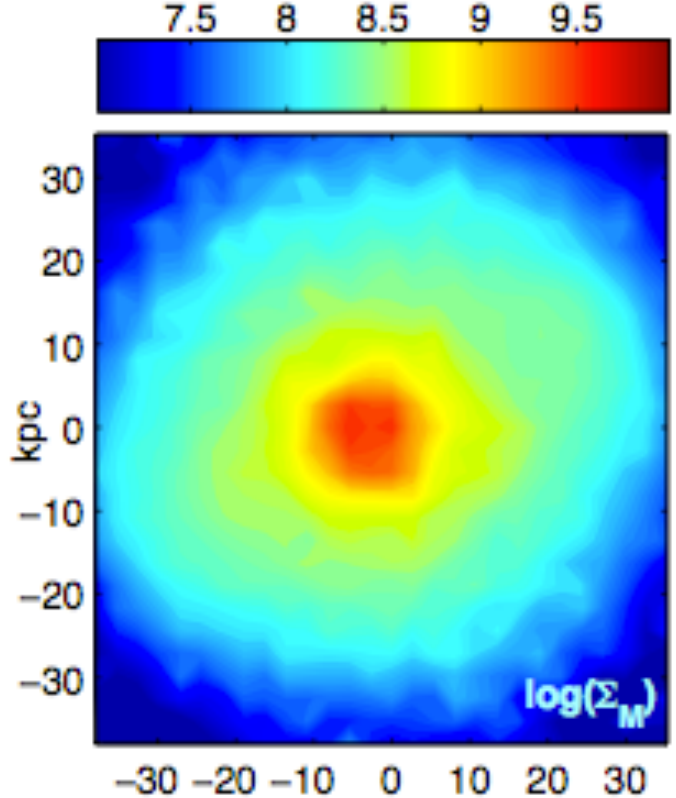
+ SSP models used to convert physical quantities in observables

Morphology



Galaxy morphology measured by means of 1D surface brightness profiles fitted with a Sersic function

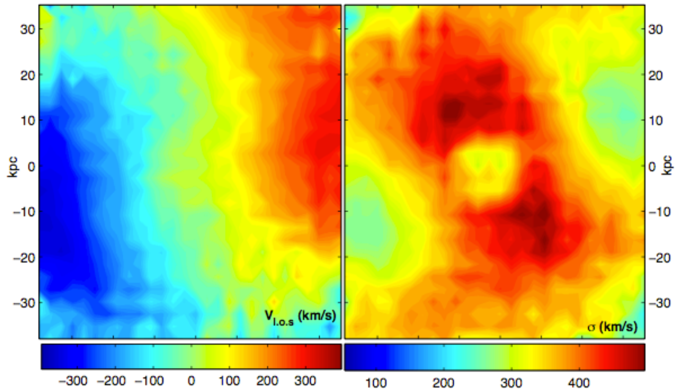
→ n, Re, μe



Early-type: n>2.5 (70%)

Late-type n<2.5 (30%)

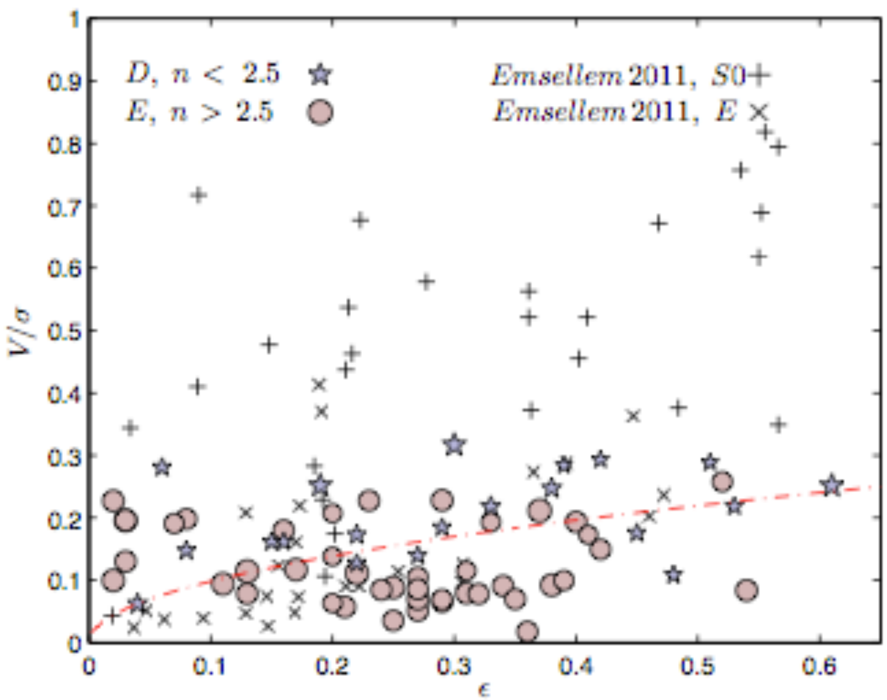
DYNAMICS



Dynamics derived from 2D projections (3 for each galaxy), following the method used in integral-field studies:

$$\left(\frac{V}{\sigma}\right)^2 = \frac{\sum_{i=1}^{N} L_i V_i^2}{\sum_{i=1}^{N} L_i \sigma_i^2}$$

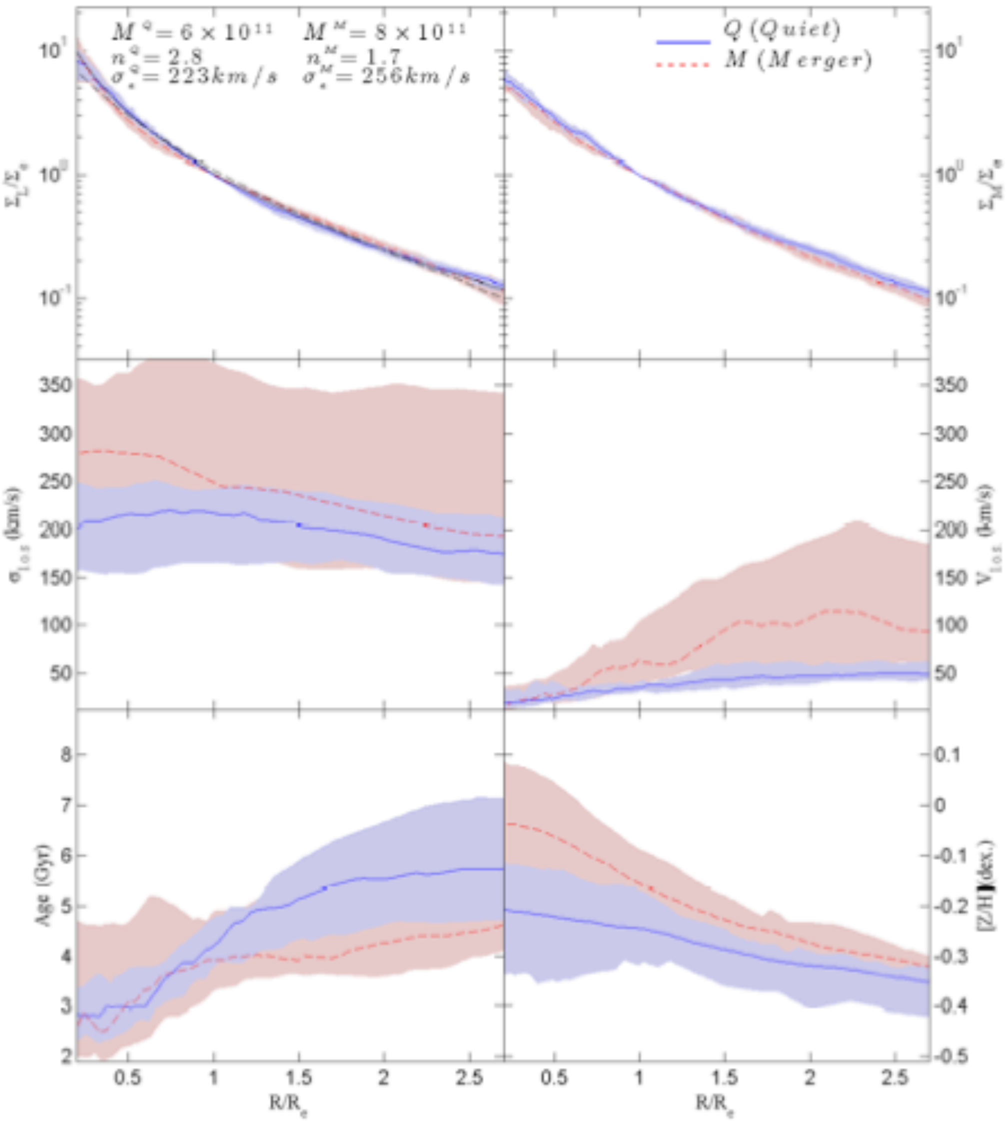
Within R_e



$V / \sigma > 0.3\sqrt{\varepsilon}$ Fast rotators (FR, 46%)

$V / \sigma < 0.3\sqrt{\varepsilon}$ Slow rotators (SR, 54%)

1D PROFILES

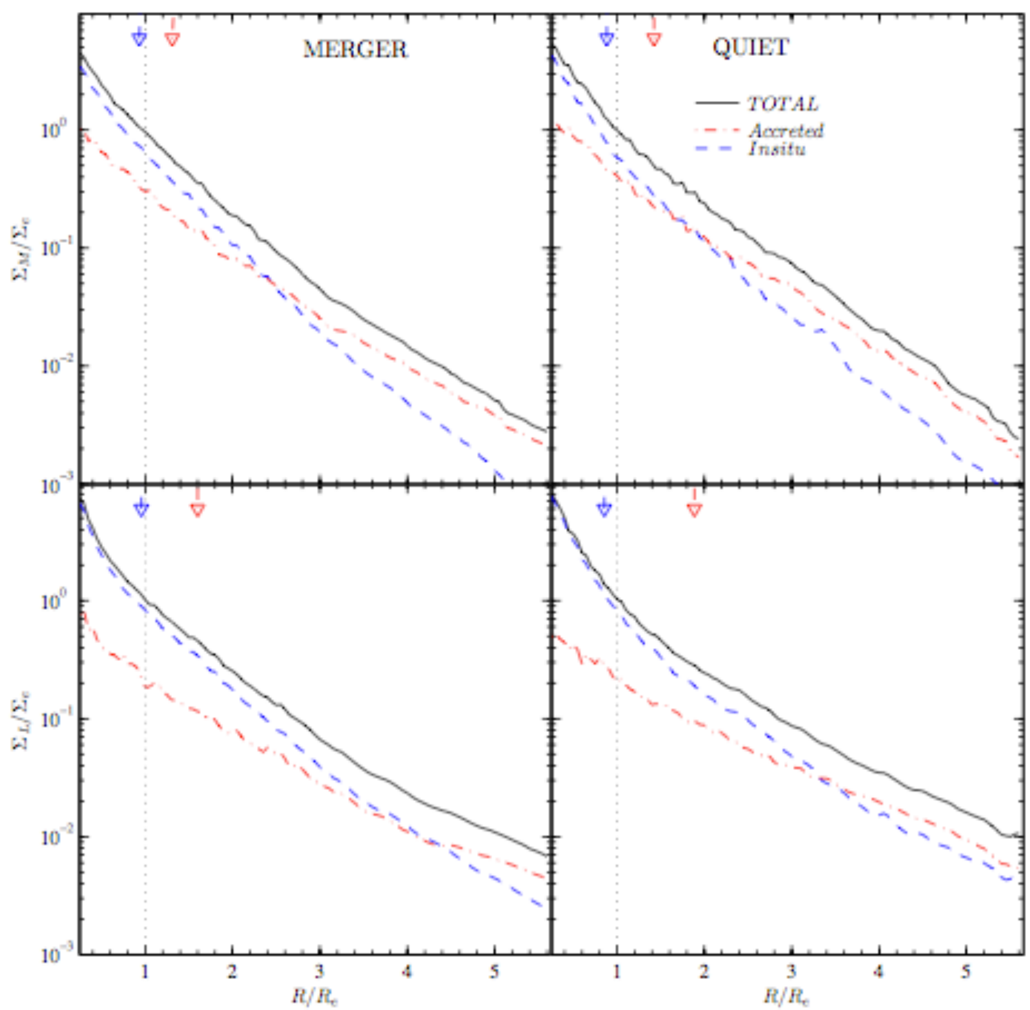


MERGER GALAXIES: HAVING UNDERGONE AT LEAST A MERGER DURING THEIR LIFE (52%)

QUIET NO SIGNIFICANT (M2/M1<0.02) MERGER (48%)

Merger galaxies have higher rotational support and steep metallicty gradients than quiet galaxies (wet mergers)

IN-SITU VS EX-SITU SF



Two-phase model of galaxy evolution (Naab +09; Oser+10, Lackner +12) :

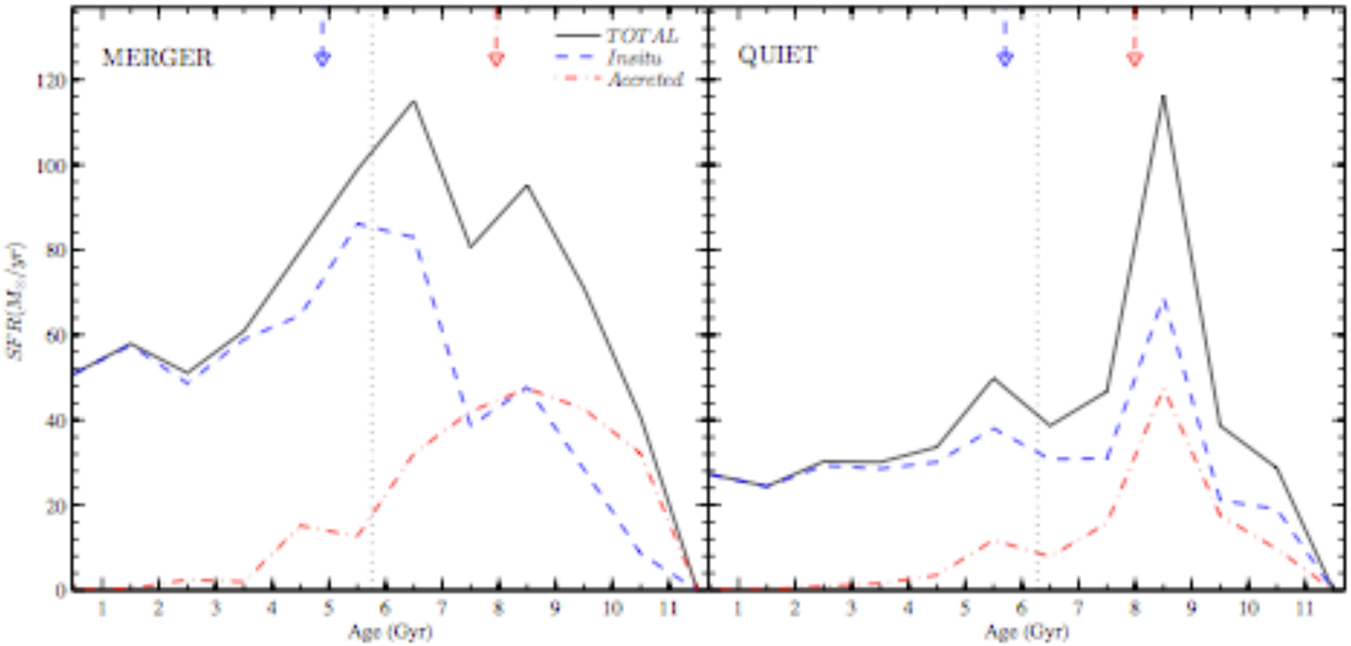
IN-SITU: formed in the main progenitor

ACCRETED: accreted via merger or smooth accretion

The majority of stars 65-70%, are formed in-situ

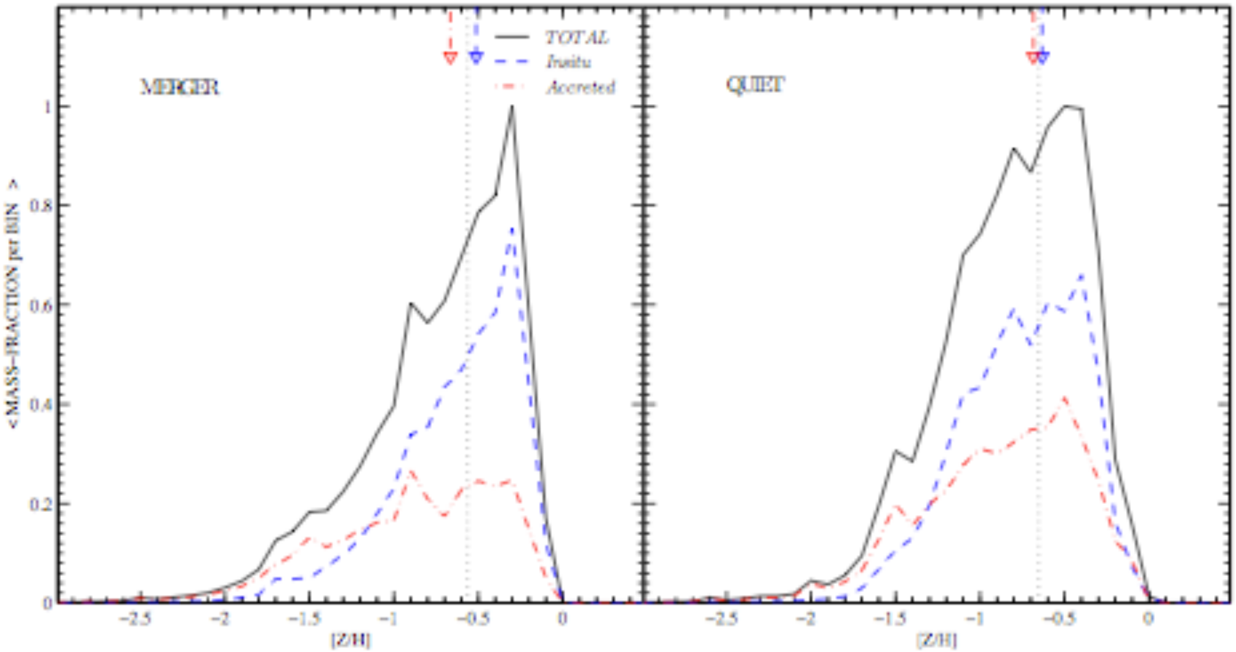
In-situ contribution dominates the central regions, ex-situ population starts to dominate in mass at 3Re and in luminosity at 4Re

SSP AGES: IN-SITU VS EX-SITU



Accreted stars are significantly older (by 3 Gyr) than the in-situ stars (see also Lackner+12)

SSP METALLICITY: IN-SITU VS EX-SITU



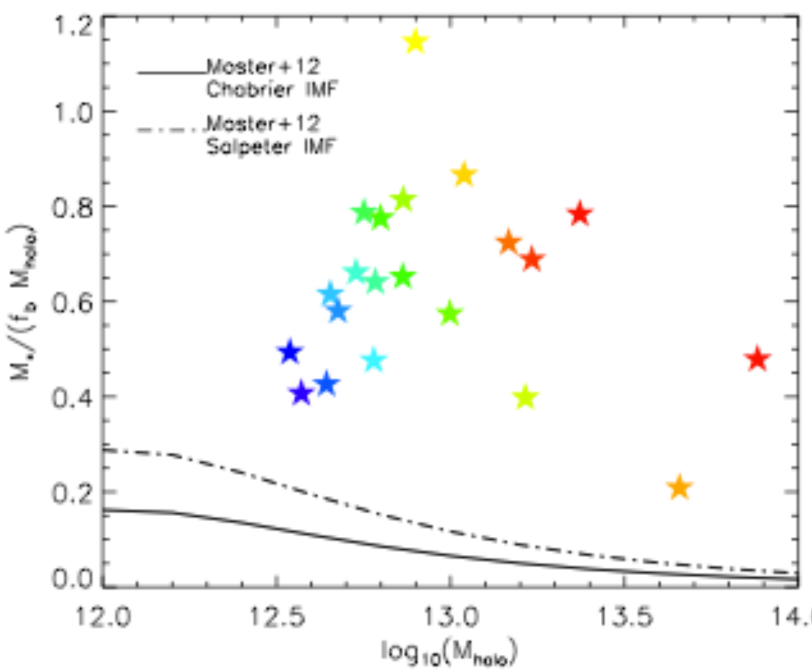
In-situ stars are more metallic than the ex-situ component, similar mean metallicity, but in-situ distribution of metallicity is skewed towards large values

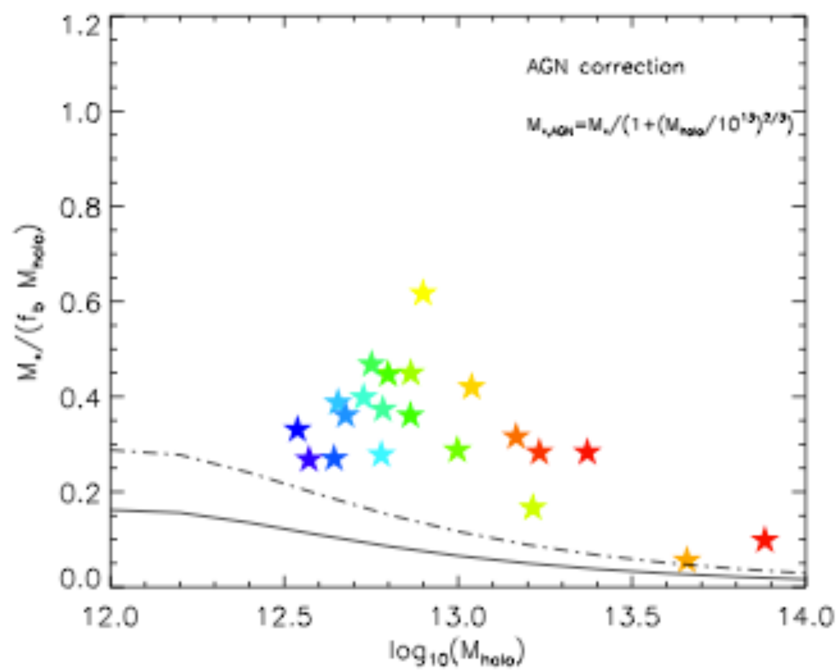
Accreted stars span a wide range of metallicity → consistent with the fact that they formed in a variety of systems

SUMMARY

- ✓ Dynamical and morphological classification of massive galaxies in a cosmological AMR simulation: most of them are early-type, equally distributed among FR and SR
- ✓ Dynamical profiles (V, σ) and SSP gradients depend on the merging history: gradients are stronger for galaxies having experienced a merger
- ✓ Most of the stars are formed IN-SITU (70%), accreted stars dominate only at large radii (3-4 Re)
- ✓ Accreted stars are older and more metal-poor than the in-situ component
- ✓ High-resolution simulations on the way to test the robustness of the results

BARYONIC CONVERSION EFFICIENCY





Our sample: <fconv> ≅ 0.63 →(With Cen (2010) prescription) 0.32

But.. See Dubois et al. (2012): AGN effect on massive galaxies can be much larger

We expect that the inclusion of AGN effect and the improvement in the resolution will solve the discrepancy